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II. "On the Structure and Affinities of *Trigonocarpon* (a fossil fruit of the Coal-measures)." By JOSEPH D. HOOKER, M.D., F.R.S. Received March 23, 1854.

Having been for some time engaged in examining the structure and affinities of some fossil fruits of the coal formation, included under the name *Trigonocarpon*, and the progress which I am enabled to make being extremely slow (owing to the difficulty of procuring good specimens), I am induced to lay before the Royal Society such results as I have arrived at, for publication in their Proceedings (if thought worthy of that honour). The details and illustrations of the subject will, when complete, be offered to the Geological Society of London.

My attention has for many years been directed to the genus *Trigonocarpon*; as, from the period of my earliest acquaintance with the flora of the carboniferous epoch, I have felt assured, that botanically, this was the most interesting and important fossil which it contained in any great abundance, and that until the affinities of this were determined, the real nature of the flora in question could never be regarded as even approximately ascertained.

In the first place, *Trigonocarpon* is so abundant throughout the coal-measures, that in certain localities some species may be procured by the bushel; nor is there any part of the formation in which they do not occur, except the underclays and limestone. The sandstone, ironstones, shales and coal itself, all contain them.

Secondly. The symmetry in form and size which many of them display, the regularity of the sculpturing on their surfaces, and various other points, suggested their belonging to a class of highly organized vegetables.

Thirdly. The fact of our being wholly unacquainted with the organs of fructification belonging to the exogenous vegetation, which also abounds in the coal formation, coupled with the assumed highly organized nature of *Trigonocarpon*, favoured the assumption that these might throw light upon one another, and seemed to afford a legitimate basis upon which to proceed, should I ever procure specimens of *Trigonocarpon* displaying structure, which I had long hoped to do.

It is, however, only since my return from India that I have been so fortunate as to obtain good specimens, and for these I am indebted to my friend Mr. Binney of Manchester, who has himself thrown much light upon the vegetation of the coal epoch, and whose exertions indeed have alone enabled me to prosecute the subject; since he has not only placed his whole collection of *Trigonocarpons* at my disposal, but has shared with me the trouble and expense of their preparation for study. All the specimens were found imbedded in a very tough and hard black-band or clay ironstone, full of fragments of vegetable matter, and which appears originally to have been a fine tenacious clay.

The individual *Trigonocarpons* are exposed by breaking this rock, and are invariably so intimately adherent to the matrix as to be fractured with it. A great many of these lumps of ironstone, containing partially exposed *Trigonocarpons*, have been sliced by a lapidary in the usual manner, and excessively thin sections taken on slips of glass. The sections were made necessarily very much at random, but as nearly as possible parallel, or at right angles to the long diameter of the fruit. Five of the specimens thus operated upon have proved instructive, presenting the same appearances, and all being intelligible, and referable to one highly developed type of plants. As, however, the term highly developed may appear ambiguous, especially with reference to a higher or lower degree in the scale of vegetable life, I may mention that by this term I mean to imply that there are in the fruit of *Trigonocarpon* extensive modifications of elementary organs, for the purpose of their adaptation to special functions, and that these modifications are as great, and the adaptation as special, as any to be found amongst analogous fruits in the existing vegetable world.

Thus, I find that the integuments of the fruit of *Trigonocarpon* are each of them a special highly organized structure; they are modifications of the several coats of one ovule, and indeed of the same number of integuments as now prevail in the ovules of living plants.

The number, structure and superposition of these, are strongly indicative of the *Trigonocarpons* having belonged to that large section of existing coniferous plants, which bear fleshy, solitary fruits, and not cones; and they so strongly resemble the various parts of the fruit of the Chinese genus *Salisburia*, that, in the present state of our

knowledge, it appears legitimate to assume their relationship to it. In all the five specimens alluded to, there are more or less perfect evidences of four distinct integuments, and of a large cavity, which is in all filled with carbonate of lime and magnesia; these minerals, I presume, having replaced the albumen and embryo of the seed.

The general form of the perfect fruit is an elongated ovoid (rather larger than a hazel nut), of which the broader or lower end presents the point of attachment, while the upper or smaller end is produced into a straight, conical, truncated rostrum or beak, which is perforated by a straight longitudinal canal. The exterior integument is very thick and cellular, and was no doubt once fleshy; it alone is produced beyond the seed and forms the beak; its apex I assume to have been that of the primine of the ovule, and its cavity the exostome. The second coat appears to have been much thinner, but hard and woody or bony; it is impervious at the apex; is also ovoid, and sessile by its broad base within the outer integument, with which it is perhaps adherent everywhere except at the apex. This is marked by three angles or ridges, and being that alone which (owing to its hard nature) commonly remains in the fossil state, has suggested the name of *Trigonocarpon*. Within this are the third and fourth coats, both of which are very delicate membranes; one appears to have been in close apposition with the inner wall of the second integument, and the other to have surrounded the albumen. These are now separated both from one another, and from the inner wall of the cavity, by the shrinking of the contents of the latter, and the subsequent infiltration of water charged with mineral matter. I may remark, however, that these two membranes may be due to the separation of one into two plates, in which case the original one was formed of several layers of cells. Hitherto I have not been able to trace any organized structure within the cavity of the fruit, and its real nature therefore remains doubtful. It is only from the strong resemblance, in structure, appearance and superposition, which these integuments present to those of Taxoid coniferæ, that I assume their probable relationship. *Salisburia*, especially, has the same ovoid fruit, sessile by its broader end, and its outer coat is perfectly analogous, being thick, fleshy, and perforated at its apex by a longitudinal canal (the exostome of the ovule); within this is a perfectly similar, woody, two or three angled, impervious integument, form-

ing the nut. This again is lined with one very delicate membrane, and contains a mass of albumen covered with a second similar membrane. A marked analogy is presented to the European botanist by the fruit of the Yew, which has the same integuments though somewhat modified; the outer, fleshy coat in the Yew is however a cup-shaped receptacle, and not drawn up over the nut so as to leave only a small canal at the top, as in *Salisburia* and *Trigonocarpon*. The nut also does not adhere to the fleshy cup except below its middle. The internal structure is the same in all three.

Such are the main facts which I have been able satisfactorily to establish. There are many others yet to be worked out, especially those connected with the individual tissues of which those bodies are composed; and it is particularly to be borne in mind that the discovery of some structure indicative of albumen or embryo, is absolutely essential to the complete establishment of the affinity I have suggested.

It must not be overlooked, that the characters through which I have attempted to establish an affinity between *Trigonocarpon* and Coniferæ are equally common to the fruits of Cycadeæ; and in connexion with this subject I may remark, that M. Brongniart* has referred the genus *Noggerathia*, which is also found in the coal-measures, to that natural order, together with some associated organs which are probably *Trigonocarpons* in a mutilated state. The leaves of *Noggerathia* are, however, alone known, and Dr. Lindley, when figuring those of one species (Lindley and Hutton, Fossil Flora, 28, 29), pointed out their great resemblance to those of *Salisburia*, thus affording collateral evidence of the view I have been led to adopt from an examination of the fruit alone.

* Annales des Sciences Naturelles, 2nd Series, vol. v. p. 52.